Functional gain following knee replacement in patients aged 75 and older: a prospective follow-up study

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VEKAMA LASSE: TOIMINTAKYVYN MUUTOS POLVEN TEKONIVELLEIKKAUKSEN JÄLKEEN 75-VUOTIAILLA JA VANHEMMILLA: PROSPEKTIIVINEN SEURANTATUTKIMUS

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Tausta ja tavoitteet: Nivelrikko on maailman yleisin nivelsairaus. Esiintyvyys kasvaa iän myötä siten, että yli 80-vuotiaista ainakin kolmannes kärsii taudista. Tekonivelleikkaus on vakiintunut nivelrikon hoidoksi, ja leikkausmäärät ovat kasvussa. Leikkaus parantaa toimintakykyä, vähentää kipua ja on kustannusvaikuttava. On kuitenkin epäselvää, ketkä hyötyvät leikkauksesta eniten. Aiemmat tulokset sairauksien ja lihavuuden vaikutuksesta ovat ristiriitaisia, kun taas radiologisten löydösten vaikutusta ei ole juuri tutkittu. Tämän prospektiivisen seurantatutkimuksen tarkoitus olikin tutkia potilaan yksittäisten sairauksien, radiologisten löydösten sekä demografisten muuttujien vaikutusta tekonivelleikkauksen jälkeiseen toimintakykyyn sekä toimintakyvyn paranemiseen iäkkäillä polvinivelrikkopotilailla.

Menetelmät: Polven nivelrikkoa sairastaville, vähintään 75-vuotiaille tekonivelleikkaukseen jonottaville potilaille (n=300) lähetettiin kysely kymmenestä eri päivittäistoiminnosta suoriutumisesta ennen leikkausta sekä vuosi leikkauksen jälkeen. Potilaista 167 (56 %) vastasi molempiin kyselyihin ja otettiin tutkimukseen mukaan. Radiologiset löydökset arvioitiin viimeisimmistä röntgenkuvista, ja tiedot sairauksista ja leikkauksen komplikaatioista kerättiin potilaskertomuksista. Potilaille laskettiin toimintakykypisteet (0-10) niiden toimintojen määränä, joista potilas suoriutui vaikeuksitta. Päätulosmuuttujina olivat toimintakykypisteet vuosi leikkauksen jälkeen sekä muutos leikkausta edeltävään tasoon. Erikseen tarkasteltiin potilaita, joiden pisteet eivät parantuneet leikkauksella. Toiminnoista suoriutumiseen vaikuttavia tekijöitä tarkasteltiin binaarisessa logistisessa regressiomallissa, joka vakioitiin iällä, sukupuolella, Charlsonin komorbiditeettiindeksillä ja nivelrikon vaikeusastetta kuvaavalla Kellgren-Lawrence-pisteillä.

Tulokset: Tekonivelleikkaus paransi suoriutumista lähes kaikissa tutkituissa päivittäistoiminnoissa. Leikkauksenjälkeisten toimintakykypisteiden mediaani (kvartaaliväli) oli 9 (6-10) ja muutos pisteissä 2 (1-4). Sydänsairauksia lukuun ottamatta tutkittujen sairauksien vaikutus toimintakykyyn ei ollut merkitsevä. Vanhempien potilaiden ja naisten lopullinen toimintakyky jäi nuorempia ja miehiä huonommaksi, mutta muutos oli yhtä suuri. Naisten joukossa oli kuitenkin enemmän niitä, joilla toimintakyky ei parantunut lainkaan. Painoindeksi ei vaikuttanut tuloksiin. Pidemmälle edenneessä nivelrikossa leikkauksella saavutettu toimintakyky jäi huonommaksi, mutta muutos oli suurempi.

Päätelmät: Tekonivelleikkaus parantaa iäkkäiden potilaiden toimintakykyä vuoden seuranta-aikana verrattuna leikkausta edeltävään tilanteeseen. Muut sairaudet, ikä tai pitkälle edennyt nivelrikko eivät saisi olla tekonivelleikkauksen esteitä eivätkä vähennä leikkauksella aikaansaatavaa toimintakyvyn paranemista.

Opiskelijan osuus työssä: Opiskelijan osuus sisälsi potilaiden sairauksia ja komplikaatioita käsittelevien tietojen keräyksen potilaskertomuksista, radiologisten kuvien analysoinnin, tilastollisten analyysien tekemisen yhteistyössä tilastotieteilijän kanssa sekä artikkelin kirjoittamisen ja korjaamisen muiden kirjoittajien kommenttien mukaan.

SISÄLLYS

Functional gain following knee replacement in patients aged 75 and older: a prospective follow-up study

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ABSTRACT**. Background and aims:** The aim of this prospective follow-up study was to analyze which patient characteristics predict better functional ability, as well as improvement in the ability, following knee replacement in the aged. The focus was on the impact of specific comorbidities and radiologic data. **Methods:** Knee osteoarthritis patients aged ≥ 75 years (n=167) scheduled for knee replacement were sent a questionnaire asking about performance in activities of daily living (ADL) before the operation, and one year afterwards. Radiologic data was evaluated from the latest radiographs, and comorbidity data from patient records. The primary outcome was a sum score indicating how many ADLs (out of 10) the patient was able to perform without difficulty. The factors associated with ADL performance were adjusted for age, gender, Charlson's comorbidity index and Kellgren-Lawrence score. **Results:** Knee replacement resulted in improved performance in almost all analyzed ADL activities. Except for cardiac diseases, the effect of the analyzed comorbidities on ADL performance was not significant. Older patients and women attained lower final functional ability than younger patients and men, but improved similarly. In more progressed osteoarthritis, the final ability was lower, but the improvement gained was greater. **Conclusions:** Comorbidity, age, or more progressed osteoarthritis should not be considered an impediment to knee replacement. Even though the final functional ability may be lower in some, the improvement gained by surgery is similar regardless of comorbidity, and was more pronounced in more progressed disease.

Key words: joint replacement, osteoarthritis, functional ability, activities of daily living

Introduction

Osteoarthritis is the most common joint disease worldwide and a leading cause of musculoskeletal disability [1]. The prevalence of clinical knee osteoarthritis (OA) increases steadily with age, so that almost half of the population aged 80 and over is affected [2]. OA is associated with pain, functional disability and impaired quality of life [3] and is one of the most disabling diseases in the aged [4, 5].

Total knee arthoplasty (TKA) is an established treatment of severe OA [6, 7]. The use of TKA is on the rise as the population ages [8]. The surgery is performed when pain, stiffness and reduced function of the knee substantially impair quality of life and non-surgical treatments are inadequate [6]. TKA not only results in improved quality of life and functional performance and reduced pain [9], but is also cost-effective [10, 11]. Furthermore, the effects of TKA are largely independent of patient age [9, 12]. However, the functional benefit after TKA is considered to be the less favorable than after total hip arthoplasty [9]. While physical function is obviously more limited in the aged after TKA when compared with younger patients [9], it is increased compared to baseline [13], and the smaller gains are possibly related to existing comorbidities [14].

Although age should not be a contraindication for TKA [13], it is unclear which older patients are those with best capacity to gain from TKA [15]. The expectations and motivation of the patient certainly play a role [16], but previously the qualities of a patient have not been very good at predicting the results [15]. The study on the effect of gender or obesity has been conflicting [13], as well as research on the effect of number of comorbidities [15, 17]. The effects of specific disease groups or radiologic findings remain to be discerned. Women may attain lower function than men, but improve similarly [17]. This might be explained by especially older women presenting with higher mobility restriction and more progressed OA at the time of surgery [7]. However, the role of comorbidities in explaining this difference is not known. Studies have often focused on the possible predicting power of obvious demographic factors [18, 19]. The criteria for surgery vary notably between surgeons [20, 21], and the most deciding factors seem to be not directly health-related [22]. Hence there is a need for more specific evidence-based criteria for selection and prioritization, especially given the ever-increasing need for TKA in the population [23].

The aim of this prospective follow-up study was to examine the effect of different comorbidities and radiological findings on the functional ability one year after TKA in osteoarthritis patients aged 75 years or over. We sought to find the patients who would benefit the most and the least from the operation, based on the information that the treating clinician already has access to.

Methods

Participants

The potential participants were identified from the patient database of a publicly-funded orthopedic hospital specializing in joint replacement in Finland, in 2010-2011. The target population of the present study consisted of patients with primary knee OA who were scheduled for primary knee replacement. Exclusion criteria were age under 75 years at the time of surgery, indication for surgery other than primary knee OA, and revision operation. Those patients failing to respond either questionnaire or who did not undergo the operation for any reason, or who responded to the first survey after the surgery, were also excluded.

Patients were mailed a questionnaire concerning their functional ability while queuing for the surgery, and one year after the operation. The non-responders in the second survey were sent a reminder three weeks afterwards. Due to the short waiting time before surgery, the first survey did not have a reminder.

The patients were recruited in two phases: between January 4th and February 26th, 2010, and between March 22nd and December 16th, 2011. We included the first 100 patients in the first phase and the first 200 patients in the second phase who fulfilled the inclusion criteria. The baseline data from the first recruitment phase have been reported previously [19]. Of the 300 patients recruited to the study, 167 responded to both questionnaires and were included in the present study (Figure 1).

Variables

The data was collected from three sources. The data about functional ability, mobility, form of dwelling and help needed in domestic tasks, as well as the need for assistive devices, was collected by a mailed questionnaire. Data on comorbidities and complications was gathered manually from patient records of the operating hospital and the adjacent university hospital. Those complications which took place before December 2013 were included. Radiologic findings were measured or evaluated from the latest radiographs taken before the operation. All the patient records and x-rays were examined by a single researcher (LV). A sample (n=20) of the x-rays was later reviewed by an experienced orthopedic surgeon (TP), who was blinded to the original measurements, for reliability of measurement.

Concerning functional ability and mobility, the patients were asked whether they were able to 1) bathe, 2) dress and undress, 3) get in and out of the bed, 4) rise from a chair, 5) do light housework, 6) do heavy housework, 7) do grocery shopping, 8) walk indoors, 9) walk 400 meters, and 10) use stairs. The response options were 1) without difficulty, 2) with difficulty, 3) only with assistance and 4) unable. These measures are well established as activities of daily living (ADL) or instrumental activities of daily living (IADL) [24, 25]. Those ADL/IADL on which TKA would not probably have an effect, such as using a telephone, were not included in the questionnaire. It has also been shown that omitting those ADL that measure primarily cognition produces a more consistent measure of ability [26].

These answers were further categorized into two classes for the analyses: 1) without difficulty, and 2) other. By summing the number of those activities the patient was able to perform without difficulty, we calculated a simple ADL score, with values 0 – 10, to represent the functional ability of the patient (ten points indicating independence in all measured ADL functions). This is based on the fact that there is a typical pattern which disability follows with respect to these activities [27]. A score similar to ours has been previously validated against known predictors of disability [26], and even though our score includes less items, they range over a similarly broad spectrum of difficulty.

The options for help needed in domestic tasks were 1) never, 2) every month, 3) every week, and 4) every day. They were categorized as either needing help or not. As for assistive devices, patients were asked separately about needing them inside and outside the house, with options 1) always, 2) sometimes, 3) never. The type of the device was also asked. The answers were categorized as 1) no devices, 2) only outside, and 3) inside and outside the house.

The data on comorbidity was gathered using a case record form specifically designed for this study, with the focus being on chronic illnesses (18 different disease groups were included), previous fractures and operations. The form was designed so that the Charlson comorbidity index (CCI) [28] could be calculated. Patient age was not included in the index, since all patients would receive the maximum points in this respect. The latest hemoglobin and creatinine levels measured before the operation were also included to spot patients suffering from anemia (defined according to local reference values: <117 g/L for women and <134 g/L for men) or renal failure (based on estimated glomerular filtration rate) without being explicitly diagnosed with such conditions. Body mass index was based on medical records instead of the questionnaire. The American Society of Anesthesiologists physical function classification (ASA score) [29] was also collected from the records.

Minimum joint space width (JSW), mechanical axis, and Kellgren-Lawrence (K-L) score [30] were examined and measured from the pre-operative axial long standing x-rays using PACS (Afga Impax 6, Agfa-Gevaert N.V, Morsel, Belgium). The skyline views were also checked for patellar dislocation. The axial deformity was classified as being over or under 11 degrees, and into separate categories for varus and valgus deformities.

Statistical analysis

The primary outcome variables were the ADL score one year after the operation, and the difference in the scores pre- and post-operatively. As a secondary outcome, we dichotomized the variable indicating change in ADL score in order to identify patients whose functional performance did not improve (postoperative score was poorer than or equal to the preoperative score).

The improvement in ADL scores was normally distributed, while the post-operation ADL scores were not. For clarity of presentation, we calculated the median, and 25th and 75th percentiles for both primary outcomes (Table 1). The statistical significance of differences in the ADL score changes were analyzed using independent samples T-test for equality of means or one-way analysis of variance, for two- or three-category variables, respectively. For post-operative ADL score, Mann-Whitney U -test and Kruskal-Wallis were used in respective analyses. The p values of the secondary outcome were calculated using chi-squared test. While the ability to perform any single ADL was not the focus of our study, we also analyzed, using McNemar's test, the change in performance separately in each activity.

Finally, factors associated with any of the outcomes were analyzed using binary logistic regression. For these analyses, we selected those variables where p was < 0.05 for any outcome variable in the univariate analyses. The regression analyses were adjusted for age group, gender, CCI (as a proxy for comorbidity), and K-L score (as a measure of severity of OA). For these analyses, we divided ADL score improvement into two classes: 1) increased at least one point, and 2) no increase. The final ADL score was respectively divided into classes 1) 0-7, and 2) 8-10.

The interobserver reliability of radiologic measurements was analyzed with Bland-Altman analysis [31]. Mean difference for axial valgus deformity was 0.13 degrees (95% limits of agreement -0.79 to 1.06). For varus deformity the mean difference was 0.044 degrees (95% LoA -1.30 to 1.38). For JSW the mean difference was 0.71 mm (95% LoA -1.30 to 2.73). The kappa for categorized K-L score was 0.43, indicating only moderate agreement which however was expected [32]. The reliability of axial deformity can be considered excellent, and the reliability of JSW adequate.

Statistical analyses were performed using SPSS for Windows version 20.0.0 (IBM Corporation, New York, U.S.). All p values were two-sided, and the limit for statistical significance was 0.05.

Ethics

This study was approved by the local board of ethics (Pirkanmaa Hospital District, Tampere; ref. num. R09223). All patients provided written informed consent to participate in the study. The study has been registered to clinicaltrials.gov (NCT01236729). The authors have no actual or potential conflicts of interest in relation to this article.

Results

The prevalence of comorbid conditions and preoperative clinical data are presented in Table 1. The median age of the 167 patients was 79 (range 75-89), and 63% were female. None of the patients reported living in sheltered housing or nursing home. 49% lived alone and 16% needed help in domestic tasks pre-operatively. 30% had undergone another joint replacement surgery previously. There were no significant

differences in gender (Pearson's chi-squared test, p=0.526) or age (Mann-Whitney U –test, p=0.338) between non-responders and responders.

The improvement in specific ADL/IADL functions is shown in Figure 2. There was improvement in all measured functions. In the most arduous activities the improvement was most dramatic. The improvement was statistically significant in all functions except for bathing.

The median final ADL score was 9 (first-third quartiles, Q1-Q3; 6-10) and median change in the ADL score was 2 (1-4). 25% of the patients showed no improvement or had poorer performance after than before surgery (Figure 3). Of the analyzed factors (Table 1), only gender, age, use of assistive devices, and cardiac diseases were associated with the final ADL score, and gender, K-L score, and type of axial deformity with the improvement in ADL score in the adjusted analysis (Table 2).

The final ADL score was higher in men (p=0.027) and in those under 80 years of age (p=0.002) (Table 1). After adjusting for K-L score and CCI, both gender (p=0.025) and age (p=0.016) remained significant (Table 2). The improvement gained by the operation did not significantly differ between the age groups, but a greater proportion of men than women had improved ADL scores (p=0.025). This difference remained significant also in the adjusted model (p=0.029). Body mass index had no effect.

The use of assistive devices indicated a poorer ADL score (p<0.001) and remained significant in the multivariable analysis (p=0.042 for devices used only outdoors, p=0.005 for no assistive devices). The need for help in domestic tasks, on the other hand, predicted a greater improvement in the score in univariate analysis (p=0.028) but the association was lost in the multivariable analysis (p=0.316).

Radiographic severity of OA was not associated with the final ADL scores. Worse K-L scores predicted greater improvement after surgery also after adjustments (p=0.041). Also varus deformity was associated with better outcome compared to valgus (p=0.018), whereas joint space width or the severity of axial deformity had no effect.

Of the comorbidities, cardiac diseases predicted distinctly poorer outcome, also in the adjusted model (p=0.003). The diseases mainly consisted of coronary artery diseases and atrial fibrillation, some patients had valvular defects or sick sinus syndrome. The effect of anemia as a predictor of poorer outcome did not hold in the adjusted model (p=0.140). While the effect of BMI did not reach significance, there was a strong trend towards those with high BMI having poorer final ADL score. Still, when BMI was analyzed as a continuous variable, the coefficient of determination R^2 was only 0.009, indicating almost nonexistent association with the outcome. High blood pressure, amongst those who had no other cardiovascular condition, narrowly reached significance (p=0.046) for a greater improvement in the ADL score. The CCI in

itself was not a significant predictor for any outcome (either categorized or continuous), nor was any other specific illnesses (Table 1). However, in some analyses, the patient numbers were small.

Sixteen patients experienced complications or had reoperations. Two patients underwent revision surgery, one underwent patellar resurfacing, and one had manipulation under anesthesia. Seven other patients had a wound-related complication (prolonged drainage, hematoma or infection) and five had prolonged pain or swelling around the knee. The median final ADL score for those who had a complication was 8.5 (Q1-Q3; 3.5-10), while in those without complications the median was 9 (6.5-10) (p=0.490). Median change of ADL score was 2 (0-3) for those with a complication, and 2 (1-4) for those without (p=0.666).

Discussion

This prospective study confirms earlier observations showing that TKA leads to improved performance in activities of daily living [12, 18, 19] and demonstrates that patient characteristics have a rather limited impact on the success of TKA operation in this respect. Few preoperative characteristics showed statistically significant association with the outcomes, and even then, their actual effect on the ADL score is low. However, heart conditions are an exception, as they independently predicted inferior performance after the surgery.

Based on the observations concerning K-L scores, the need for assistive devices and assistance in domestic tasks, it seems clear that when the OA progresses, the improvement gained from the surgery increases. The final functional ability, however, remains lower than if the surgery had been performed earlier. Our study supports the previous findings in this regard [33]. The effect of K-L score on the improvement in functional ability has been noted previously [34], and while we did not find an inverse correlation on the postoperative functional ability, such a correlation could not be ruled out. The improvement in ADL scores was clearly superior in patients with preoperative varus deformity as compared to those with a valgus deformity. Even though the type of axial deformity does not seem to affect the outcome of TKA [35], patients with varus deformity have impaired gait pattern and greater pain and disability preoperatively [36], and thus, they have plausibly more to gain from surgery.

The present study confirms and extends the existing knowledge in many ways. We found that age over 80 and female gender predict poorer final outcome, but the improvement of ADL score does not depend on age, as has been shown previously [7, 9, 13]. What comes to gender, it seems that while men and women improve similarly on average, a relatively large proportion of women did not improve at all. This difference in outcome variables, if confirmed in a larger sample, could well explain the discrepancy of previous studies [13, 17]. We attempted to account for the fact aged women present with more advanced OA than men [7] by adjusting for K-L score. However, it is a rather crude method for assessing the severity of OA since the

variation in those eligible for TKA is low. Still, other methods of severity assessment, such as JSW and the severity of axial deformity, were not associated with improvement.

While the low effect of general comorbidity has previously been noted [13, 15, 17], the results concerning the effect of heart conditions are, to the best of our knowledge, novel. As the change in ADL score was similar in patients with and without cardiac disease, the poorer overall performance appears to be related to the cardiac disease rather than to TKA. Later cardiovascular complications might also explain the effect, although patients aged 80 years have a low risk of such complications from TKA [37].

The effect of high blood pressure is just barely significant. As those with a more serious cardiovascular condition were exlcluded from that analysis, the sample size is also small and there is no plausible mechanism explaining the result. Hence, the finding is likely coincidental. The apparent predictive value of undergoing bilateral surgery is very likely due to the fact that patients undergoing such surgery have to be considerably healthier than average TKA recipients. In previous studies, depression has adversely affected post-operative function [38, 39], but we found no such effect, possibly due to the small number of patients with depression.

Our study has several strengths. Patients were treated in a single hospital within a period of a few years. Thus the treatment and indications for surgery was similar for all patients. The response rate was satisfying at 67%. Often there has been a comparison group of non-operated patients in studies concerning mobility [12, 18, 40], causing inevitable selection bias. In the present prospective setting such a bias could be avoided. Also, the manual examination of patient records and radiographs avoided the recall bias that would ensue, should this information be also collected using questionnaires. We were also able to investigate whether complications would explain a poorer improvement or outcome, and found no such connection.

We acknowledge some weaknesses of our study. Although the patients in our study had considerable comorbid burden, those with the most severe conditions and poorest health were probably not considered candidates – or were not willing themselves – to undergo surgery. Therefore, all aged patients suffering from OA cannot be expected to gain similar benefit from the operation. Furthermore, we could not determine whether the OA of other joints had an effect on the ADL scores. However, the effect of other existing joint replacements was not significant for any of the outcomes. The number of patients in some disease groups was very low. As we retrospectively reviewed patient records, we could not assess the effect of undiagnosed geriatric conditions, such as cognitive disorders or malnutrition, or take into account the severity of individual diseases.

Since the ADL score of many patients was decent even before surgery (42 patients had a score of 8 or higher), there was a definite ceiling effect on the score improvement. However, we sought to circumvent

this by analyzing the secondary outcome variable of whether there was any improvement at all, as only four patients had a score of 10 before surgery, and found no significant predictors apart from gender. The factors that predict gaining no improvement from TKA thus remain unclear.

Conclusion

Knee replacement has a definite positive impact on the functional ability also in the oldest patients. The effect of comorbidities on the outcome is generally small, however cardiac diseases, as well as female gender and age > 80 years, predict poorer outcome. Nevertheless, the surgery remains beneficial also for these patients, as they mostly show gains in functional ability similar to other patients, compared to their own baseline. Patients with more advanced osteoarthritis gained more in ADL score than those with milder osteoarthritis preoperatively. Further research is needed on a larger population to evaluate the outcomes in the longer term and to explore the mechanisms behind these results in more detail. Further, the group of patients not benefitting from the surgery will require more detailed attention.

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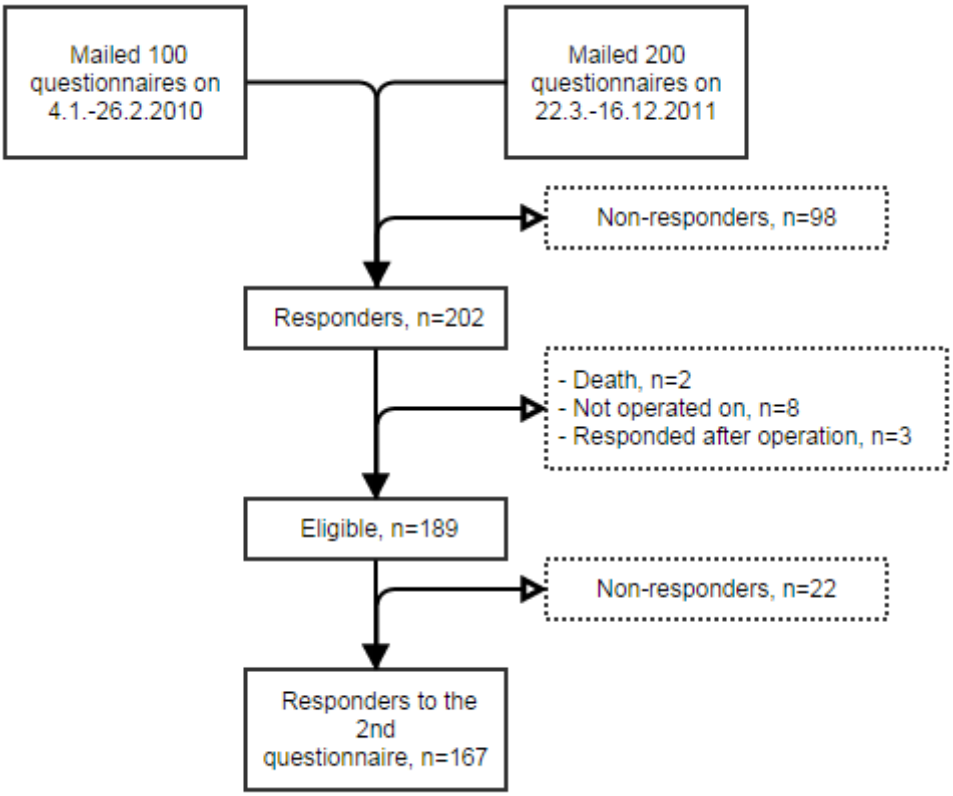

Fig. 1 Patient recruitment

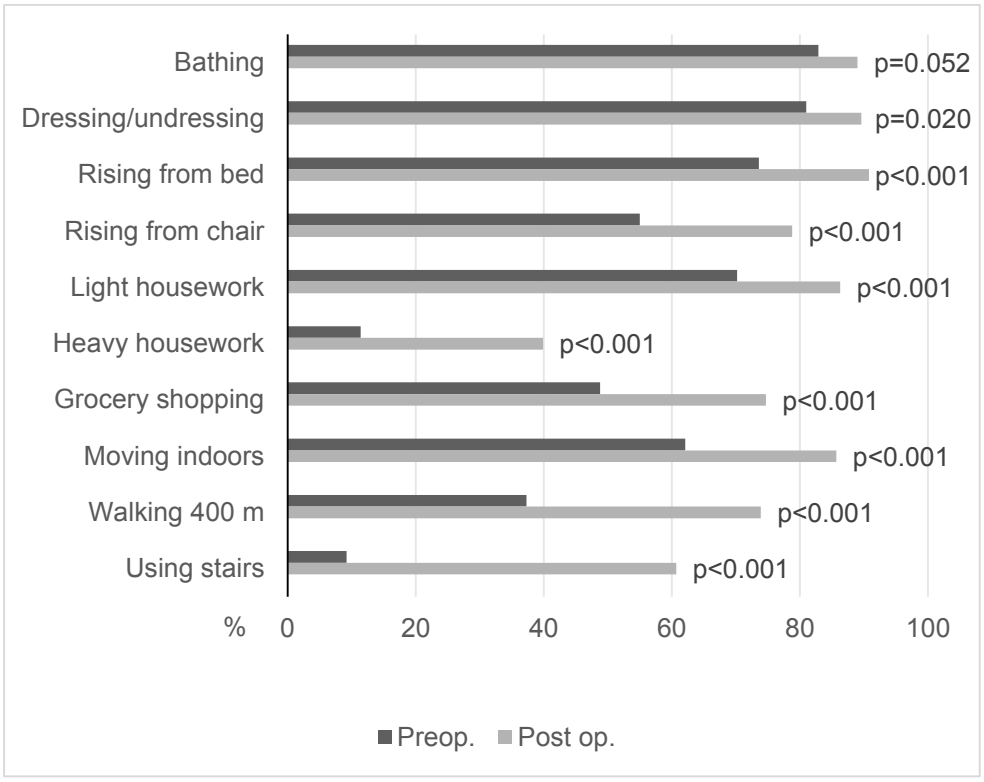

Fig. 2 Proportion of patients being able to perform different basic and instrumental activities without difficulty

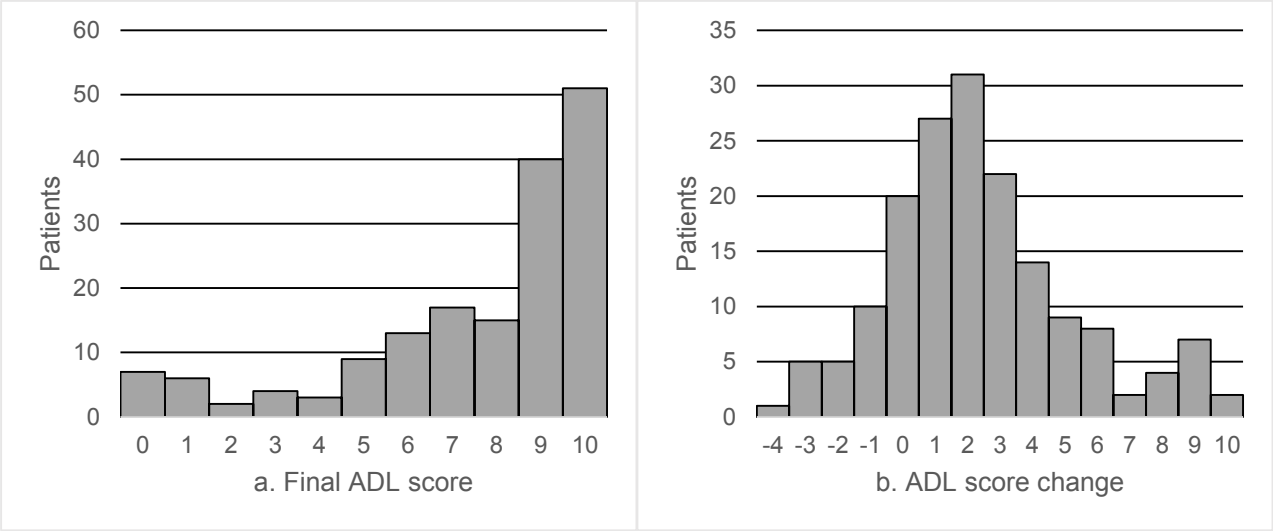

Fig. 3 Patients' ADL score one year after TKA (a), and the change of ADL score compared to baseline (b)

Table 1 Patients' characteristics and their association with final ADL score, change in ADL score, and gaining no improvement in ADL score.

		N	%	Final ADL score *	p	Change *	p	No improvement, %	p
Patient demographics and preoperative state									
Age group	< 80	110	66	9 (7 - 10)	0,002	2 (1 - 4)	0.244	22	0.262
	80 +	57	34	8 (6 - 9)		2 (0 - 3)		30	
Gender	Female	105	63	9 (6 - 9)	0,027	2 (0 - 3)	0,160	31	0.025
	Male	62	37	9 (7 - 10)		2 (1 - 4)		15	
Need for help with domestic tasks	No	82	49	9 (6 - 10)	0,762	2 (0 - 3)	0.028	29	0.208
	Yes	85	51	9 (7 - 10)		2 (1 - 4)		20	
Use of assistive devices	No	68	42	9 (7,5 - 10)	<0.001	2 (1 - 4)	0.862	24	0.797
	Only outdoors	56	34	9 (6 - 10)		2 (0 - 3)		27	
	Also indoors	39	24	6 (3 - 9)		2 (1 - 4)		21	
BMI	≤ 25	22	13	9,5 (6 - 10)	0,153	1,5 (0 - 3)	0.159	32	0.604
	25.01 - 30	82	50	9 (7 - 10)		2 (1 - 4)		22	
	> 30	59	36	8 (6 - 9)		2 (1 - 4)		24	
Bilateral operation	No	162	97	9 (6 - 10)	0,005	2 (0 - 4)	0.297	25	0.335
	Yes	5	3	10 (10 - 10)		2 (2 - 7)		0	
Previous joint replacement	No	117	70	9 (6 - 10)	0,439	2 (1 - 4)	0.187	24	0.845
	Yes	50	30	9 (6 - 10)		2 (0 - 3)		26	
Previous operations on the knee	No	127	76	9 (6 - 10)	0.784	2 (1 - 4)	0.32	24	0.675
	Yes	40	24	9 (6,5 - 10)		2 (0 - 4)		28	
Radiographic findings									
Kellgren-Lawrence score	2-3	80	48	8 (6 - 10)	0.305	1 (0 - 4)	0.033	31	0.072
	4	86	52	9 (6 - 10)		2 (1 - 4)		19	
Joint space width, mm	≤ 1	79	48	9 (6 - 10)	0.617	2 (1 - 4)	0,140	22	0.349
	2 - 3	62	37	9 (6 - 10)		2 (1 - 4)		24	
	4+	25	15	8 (6 - 9)		1 (-1 - 4)		36	
Mechanical axis, valgus, degrees	< 11	27	75	7 (5,5 - 9)	0.416	1 (0 - 2)	0.569	41	0,700
	≥ 11	9	25	9 (7 - 9)		0 (0 - 3)		56	
Mechanical axis, varus, degrees	< 11	96	74	9 (7 - 10)	0.571	2 (1 - 4)	0.688	21	0.466
	≥ 11	34	26	8,5 (6 - 10)		3 (1 - 4)		15	
Mechanical axis	Valgus	36	22	8 (6 - 9)	0.103	1 (0 - 2.5)	<0.001	44	0.003
	Varus	130	78	9 (6 - 10)		2 (1 - 4)		19	
Comorbidity									
ASA classification	2	55	36	9 (7,5 - 10)	0.096	2 (1 - 3)	0.56	24	0.269
	3	93	62	9 (6 - 10)		2 (1 - 4)		24	
	4	3	2	7 (6 - 7,5)		0 (0 - 2,5)		67	
Charlson comorbidity index	0	73	44	9 (6 - 10)	0.157	2 (1 - 4)	0.912	25	1,000
	1 - 2	72	43	9 (7 - 10)		2 (0,5 - 4)		25	
	3 +	22	13	7 (3 - 9)		2 (1 - 4)		23	
Cardiac disease	No	99	59	9 (7 - 10)	0.002	2 (1 - 4)	0.769	21	0.273
	Yes	68	41	7 (5 - 9)		2 (0 - 4)		29	
Hypertension without other cardiac disease	No	31	31	9 (8 - 10)	0.775	1 (0 - 2,5)	0.046	29	0.288
	Yes	68	69	9 (7 - 10)		2 (1 - 4)		18	
Type 2 diabetes	No	134	80	9 (7 - 10)	0.137	2 (1 - 4)	0.566	23	0.498
	Yes	33	20	7 (4 - 10)		2 (0 - 4)		30	
Chronic lung disease	No	144	86	9 (6 - 10)	0.444	2 (1 - 4)	0.698	24	0.602
	Yes	23	14	9 (7 - 10)		1 (0 - 4,5)		30	
Gastrointestinal disease	No	154	92	9 (6 - 10)	0.105	2 (1 - 4)	0.198	23	0.088
	Yes	13	8	7 (2 - 9)		2 (-1 - 3)		46	
Eye disease	No	106	63	9 (7 - 10)	0.101	2 (1 - 4)	0.565	21	0.314
	Only operated cataract	47	28	8 (7 - 9,5)		2 (0 - 3,5)		30	
	Other than operated cataract	14	8	6 (5 - 10)		1,5 (-1 - 4)		36	
Cancer history	No	142	85	9 (6 - 10)	0.78	2 (0 - 4)	0.872	26	0.326
	Yes	25	15	8 (7 - 10)		2 (1 - 4)		16	
Dementia	No	162	97	9 (6 - 10)	0.81	2 (1 - 4)	0.867	24	0.597
	Yes	5	3	9 (1 - 10)		2 (-2 - 5)		40	
Cerebrovascular disease	No	148	89	9 (6,5 - 10)	0.201	2 (1 - 4)	0.447	24	0.571
	Yes	19	11	8 (6 - 9)		1 (0 - 3)		32	
Vertigo	No	152	91	9 (6 - 10)	0.71	2 (1 - 4)	0.421	24	1,000
	Yes	15	9	9 (6,5 - 9)		3 (1 - 5)		27	
Neurologic condition	No	152	91	9 (6 - 10)	0.832	2 (1 - 4)	0.974	24	1,000
	Yes	15	9	9 (4,5 - 10)		2 (0,5 - 4)		27	
Depression	No	162	97	9 (6 - 10)	0.866	2 (1 - 4)	0.715	25	1,000
	Yes	5	3	9 (7 - 10)		2 (2 - 5)		20	
Back condition or operation	No	145	87	9 (7 - 10)	0.865	2 (1 - 4)	0.117	23	0.428
	Yes	22	13	8,5 (5 - 10)		1 (0 - 3)		32	
Previous fracture	No	138	83	9 (6 - 10)	0.822	2 (1 - 4)	0.919	25	1,000
	Yes	29	17	9 (7 - 10)		2 (1 - 4)		24	
Anemia (Hb < 117 F, < 134 M)	No	124	82	9 (7 - 10)	0.017	2 (1 - 4)	0.088	23	1,000
	Yes	28	18	7,5 (5,5 - 9)		2 (0,5 - 3)		25	
Renal insufficiency	Severe	3	2	5 (3 - 5,5)	0.079	1 (-0,5 - 1,5)	0.399	33	0.864
	Moderate	45	30	9 (6 - 10)		2 (0 - 4)		27	
	Mild or normal	104	68	9 (7 - 10)		2 (1 - 4)		22	

* Median (first-third quartiles)

Table 2 Odds ratios (OR) with their 95% confidence intervals (CI) for a) having a good ADL score after surgery, and b) gaining an improvement in the score. Odds ratios were calculated using binary logistic regression adjusted by gender, age group, CCI and K-L score.

	Univariate OR (95 % CI)	Multivariable OR (95 % CI)
Final ADL score 8-10		
Age group		
80 +	1	1
< 80	2.25 (1.16-4.36)	2.31 (1.17-4.58)
Gender		
female	1	1
male	2.16 (1.08-4.29)	2.30 (1.11-4.75)
Assistive devices		
indoors	1	1
only outdoors	2.80 (1.20-6.51)	2.52 (1.04-6.14)
no	4.31 (1.86-10.01)	3.61 (1.48-8.78)
Cardiac disease		
yes	1	1
no	2.98 (1.55-5.72)	2.87 (1.42-5.80)
Anemia		
yes	1	1
no	2.10 (0.92-4.82)	2.01 (0.80-5.08)
ADL score increased after operation		
Gender		
female	1	1
male	2.58 (1.14-5.86)	2.58 (1.10-6.04)
Help with domestic tasks		
yes	1	1
no	0.60 (0.30-1.23)	0.67 (0.31-1.46)
Kellgren-Lawrence score		
2-3	1	1
4	1.99 (0.97-4.09)	2.19 (1.03-4.65)
Mechanical axis		
Valgus	1	1
Varus	3.36 (1.53-7.40)	2.73 (1.18-6.29)